Electron Localization Effects, Polarons and Clustered States in Colossal Magnetoresistive Manganites

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The discovery of the colossal magnetoresistance (CMR) effect has motivated intensive studies of manganese oxides with perovskite structure and formula unit $ABMnO_3$, (A = rare earth atom, B = divalent atom). Besides the double-exchange (DE) model, which provides a qualitatively correct description of the CMR effect, of particular importance for the physics of the CMR oxides is the presence of short-range-ordered Jahn-Teller distortions (JTDs) of the MnO_6 octahedra and polaron formation.

I will discuss the temperature-dependent evolution of the electronic and local crystal structure of the prototypical CMR compound $La_{0.7}Sr_{0.3}MnO_3$ (LSMO). By means of a unique combination of spectroscopic and structural probes, it has been possible to take a direct look "inside" polaron formation in this material, establishing a direct link between local Jahn-Teller distortions and the concomitant charge localization [1,2]. These results challenge the long-standing belief that the LSMO compound is a simpler DE system which could be described without the formation of polarons, and further suggest that the presence of polarons above the Curie temperature is a general defining characteristics of all of the CMR materials, thus bringing unity to their theoretical description. Relationship of these data to other recent work suggesting heterogeneity, phase separation and ferromagnetic clusters in strongly correlated oxides will also be discussed.

[1] Mannella et al., Phys. Rev. Lett. 92, 166401 (2004)
[2] Mannella et al., Phys. Rev. B 71, 125117 (2005)